A 10 POINT SURGICAL APGAR SCORE TO PREDICT POST OPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING GENERAL SURGICAL PROCEDURES

Dissertation submitted in

Partial fulfilment of the regulations required for the award of

M.S. DEGREE

In

GENERAL SURGERY

THE TAMILNADU

DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI

APRIL 2016

DECLARATION

I hereby declare that the dissertation entitled **"A 10 POINT SURGICAL APGAR SCORE TO PREDICT THE POST OPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING GENERAL SURGICAL PROCEDURES"** was done by me in the Department of General Surgery at Coimbatore medical college hospital during the period from September 2014 to September 2015 under the guidance and supervision of Prof. Dr. G. Ravindran M.S., Department of General Surgery, Coimbatore medical college hospital. This dissertation is submitted to the Tamilnadu Dr. M.G.R Medical University, Chennai towards partial fulfilment of requirement for the award of M.S. Degree in General Surgery. I have not submitted this dissertation on any previous occasion to any university for award of any degree.

Place:

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CERTIFICATE

This is to certify that the dissertation entitled **"A 10 POINT SURGICAL APGAR SCORE TO PREDICT THE POST OPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING GENERAL SURGICAL PROCEDURES"** is a record of bonafide work done by **Dr. VINOD KUMAR. T** under the guidance of **Prof. Dr. G. Ravindran M.S.,** Department of General Surgery, Coimbatore Medical College and Hospital. This is submitted for partial fulfilment of the regulations for the award of M.S Degree in General Surgery by The Tamilnadu Dr. MGR Medical University, Chennai. This work has not previously formed the basis for the award of a degree or diploma.

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Dissertation Topic : A 10-point surgical APGAR score to predict post operative morbidity & mortality in patients undergoing general surgical procedures.

The Ethics Committee, Coimbatore Medical College has decided to inform that your Dissertation Proposal is accepted / ~~Not accepted~~ and you are permitted / ~~Not permitted~~ to proceed with the above Study.

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Page count:	78
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Submission date:	19-Sep-2015 12:46PM
Submission ID:	560479509


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GENERAL SURGERY
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ACKNOWLEDGEMENT

On completing this dissertation I would like to use this opportunity to thank everyone who helped me with this study. First and foremost I am extremely happy to express my gratitude towards my unit chief and my mentor **Prof.Dr. G. Ravindran M.S**., who guided me right from the start of my post graduation. I am very grateful for his valuable guidance during my thesis work. I am grateful to Prof. Dr. V.Elango, M.S., Professor and Head of the Department of General Surgery, Coimbatore Medical College Hospital, for his valuable inputs. I also thank my Assistant Professors Dr. Muthulakshmi and Dr. Srinivasan for helping me in this study. I express my gratitude to Dr.Edwin Joe, Dean, Coimbatore Medical College Hospital for permitting me to carry out my study in this Hospital. Last, but not the least, I heartily thank all the patients for their kind support without whom this study could not have been done.

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INTRODUCTION

Healthcare providers, including hospital teams and surgeons, endeavour to consistently lower the incidence of complications for a patient undergoing any surgical procedure. A vital aspect of managing risk in the practice of surgery is the prediction of complications following surgery.

Recognizing patients at high risk or having a high probability of developing peri-operative complications will significantly contribute to the improvement of the quality of a particular operation and reducing the healthcare cost. Differences in post-operative outcomes are usually due to variability in patient's perioperative risk factors.[1]

Any model, to be an ideal predictor of complications in a patient undergoing surgery should be, in addition to being simple, should readily be applicable to any patient being operated. The development of a model for predicting complications in surgical patients requires a precise estimation of the occurrence of the complications. Hence, an appropriate definition of various complications of surgery, which can be easily detected, is necessary.

However, the response of the body to surgical stress is variable intra-operatively, in terms of vital parameters such as the patient's

heart rate, arterial blood pressure, percentage saturation and tissue or organ perfusion. This further contributes to the variability in patients' risk of developing complications.[1]

The evolution of better monitoring techniques and well equipped laboratories have led to the development of newer general and specialized surgical scoring systems, such as:-

General:APACHE II, MODS (Multiple Organ Dysfunction Score), SAPS II, TRIOS (Three days Recalibrated ICU Outcome Score), etc.

Specialized/Surgical: POSSUM (Physiologic and Operative Severity Score for the Enumeration of Mortality and Morbidity), Glasgow Coma Score for neurosurgical patients, MPM for cancer patients, NSQIP (National Surgical Quality Improvement Program), etc.

However, calculating these scores at the bedside is tedious. These scores necessitate the estimation of numerous parameters including patient characteristics and lab data which are not collected uniformly rendering them prone for errors, thereby losing reproducibility among various teams involved in patient care.

The methods of surgical quality assessment available at present, such as the National Surgical Quality Improvement Program (NSQIP)[2-4], developed by the American College of Surgeons, indirectly evaluate the surgical performance, i.e., by assessing the various risk factors in the pre-operative period and by comparing the discrepancies between the observed complication rates and the expected rates to a particular treatment being provided.

For example, the pre-operative factors which predict postoperative morbidity, in small bowel obstruction surgeries, include a history of congestive cardiac failure, any chronic obstructive pulmonary disease, cerebrovascular accident with neurological deficit, total leucocyte count < 4500/cu.mm^3, creatinine value > 1.2 mg/dl in the pre-operative period, and advancing age. The factors which predict morbidity intraoperatively comprise a higher wound class and the ASA class. Operative factors such as simple small bowel resection in comparison to adhesiolysis alone has higher incidence of complications and morbidity[5].

The pre-operative risk factors which have a definite impact on the mortality are a positive history of metastatic malignancy, pre-operative haematocrit value< 38%, pre-operative creatinine value> 1.2mg/dl, preoperative sodium value > 145mg% and advancing age.

Factors which predict mortality intraoperatively are higher wound class and advanced ASA class. But, various studies have found that elevated leucocyte count occurs more often in patients requiring adhesiolysis when compared to patients going for small bowel resection, indicating the unreliable nature of leucocytosis in differentiating infection and inflammation[5].

In the operation theatre, most surgeons' rely on "gut feeling" instead of objective assessment, regarding the course of the operation and the post-operative prognosis[6]. These models rate the patient in broad categories and provide a clinical guide regarding patient's postoperative care.

The operative management of a patient contributes to the overall outcome of a surgery, but measures to quantify the operative care are not readily available.[1] The factors causing alteration in patient's condition intra-operatively, which include hypertension, hypotension,[7] hypothermia, tachycardia, bradycardia,[8.9] and blood loss[10], have been identified as independent links for unfavourable perioperative outcomes. Several models available for risk prediction have incorporated these variables for early prediction of postoperative mortality and morbidity. Nevertheless, a clear consensus on the ideal or the most applicable postoperative risk assessment model has not

been reached.[11] Hence, the question of evaluating performance and operating room safety remains unanswered in surgeon's mind.[12]

In order to make a simple, impersonal and direct method of risk grading available to surgeons, a Surgical Apgar Score was determined by Atul Gawande et al.[13] Several parameters recorded in the operation theatre were assessed, and three variables were found to be independent predictors of most complications in the postoperative period and death. These variables were – patient's lowest heart rate during surgery, estimated loss of blood during the procedure and the lowest mean arterial pressure. These three predictors have helped build a score which has proved beyond doubt as a very strong predictive model for categorizing patients who are at increased risk of developing complications in the postoperative period and death following general surgical procedures and vascular surgical procedures.[13]

This scoring system requires data which can be collected immediately upon completion of a procedure, regardless of the technological capacity and the resources available, and in any setup, making it the simplest available scoring system for assessing the risk.

Similar to the obstetrical Apgar score,[14] this score cannot assess the quality and standard of care by itself, as the three variables being

taken into consideration are influenced by the surgical teams' performance, and also the pre-operative physiological status of the patient and the nature and complexity of the procedure they undergo.[15] In order to be a useful predictor clinically of post-surgical morbidity and mortality, each component of the score or the score as a whole should contribute to predict the surgical outcome.

This score's simplicity, availability in real time, immediate applicability in decision making and inexpensive nature make it a powerful tool for early recognition of complications. Such an early predictability helps improve safety in surgery. As the feedback is almost immediate, this helps the surgical team in categorizing patients who need more intense postoperative monitoring and care and those who are expected to pass through an uncomplicated course.

This scoring system can act as a mode of communication between the nursing staff, residents and surgeons regarding the immediate postoperative status of a patient and thereby assist in decision making, such as need for admission after an OP procedure/day-care procedure, admission to ICU or the need for frequent visits to the surgeon postoperatively. Even in a patient with low surgical Apgar score but an uncomplicated outcome, it would

enable early identification of problems, as these patients are subjected to repeated reviews and routine clinical surveillance.

The ability of the surgical Apgar score to predict the risk of post-surgical complications in patients undergoing general surgical procedures will be evaluated in this study.

AIM AND OBJECTIVES

AIM:

To predict the risk of postoperative complications in patients undergoing general surgical procedures

OBJECTIVES:

- To identify patients at risk of developing postoperative complications based on intraoperative data
- To study the incidence of postoperative complications in patients undergoing elective and emergency general surgical procedures
- To study the morbidity and mortality which are associated with various surgical procedures

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Introduction

The appraisal of the various potential risk factors of peri-operative morbidity and mortality is vital for improving the standard of health care. Healthcare providers nowadays have an increasing awareness about the need to ensure appropriate utilisation of all the available resources. Doing this would enable the most deserving patient to get the most appropriate healthcare available in the hospital.[16]

Adequate risk stratification, as an aid to clinical practice, is therefore considered essential. Assessment of patients for the purpose of categorization may be carried out at various stages during the course of a patient's stay in the hospital, i.e., from the OPD to the ward to the OT to the ICU. With respect to an operation, it can be grouped into three stages:

1. Preoperative assessment - This is the stage of planning an intervention which can help in identifying and quantifying the possible risks of a particular surgical procedure for a patient with respect to patient's inbuilt physiological and acquired pathological comorbidities.
2. Perioperative assessment - This can help determine the most appropriate setting for further care of the patient. This is based on

the preliminary risk stratification done at the time of patient's arrival in the hospital.

3. Postoperative score - This is calculated from the patient's intraoperative variables and the patient's responses to these variations. This may alter the subsequent management of operated patients.[17]

One of the most prominent works on risk prediction was done by P. M. Markus, J. Martell et al, during which patients undergoing gastrointestinal or hepatobiliary surgery were studied prospectively.[18] They included both elective (827) and emergency (250) procedures. The possible occurrence of postoperative complications was predicted on a scale of 0 to 100 per cent, based on the gut-feeling of the surgeon, soon after completion of the procedure. This was followed by comparing these predictions with predictions made using POSSUM (Physiological and Operative Severity Score for the Enumeration of Morbidity and Mortality) and with the actual outcome.

The morbidity rate was observed to be 29.5 per cent and mortality rates was 3.4 per cent, whereas POSSUM predicted a morbidity rate of 46.4 per cent and a mortality rate of 6.9 per cent was predicted by P-POSSUM (Portsmouth POSSUM). The prediction based on the gut feeling of the operating surgeon was 32.1 per cent which was more

accurate. However, surgeons tend to over predict the mortality rates in patients undergoing elective surgery, whereas in emergency procedures, the rate is underestimated.[18]

The postoperative morbidity and mortality as shown in the figure is associated with three major categories of risk factors.

1. Patient co-morbidity
2. The surgical procedure itself
3. Risks related directly to anaesthesia management

Earlier studies identified the extremes of age as a risk factor for perioperative complications. Infants and older persons (65+ years) experience higher postoperative mortality than persons in the 2-64 years.[18]

An emergency procedure imparts nearly 8 times increased risk of death within 48 hours and 3 times increased risk of death within 30 days postoperatively. Postoperative ICU admission is associated with 2-3 times increased risk of postoperative mortality. Any surgery associated with a perioperative adverse event imparts a 12 times increased risk of death within 48 hours postoperatively and 4 times increased risk within 30 days postoperatively.[19]

ASA is a well-established measure of patient comorbidity. Higher ASA scores are associated with increased risk of postoperative mortality. Approximately, 35 per cent of ASA grade V patients die within 48 hrs and 50 per cent within 30 days postoperatively. Both these rates are higher after emergency procedures or after procedures resulting in ICU admissions.

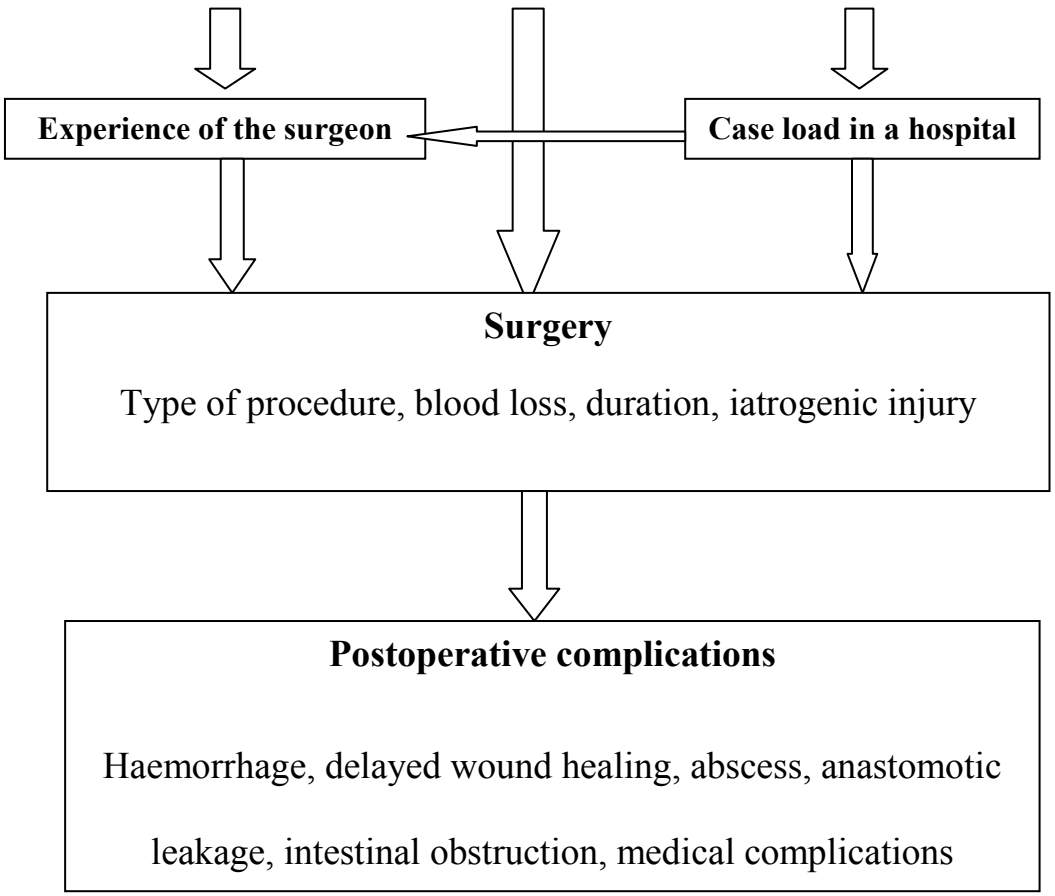


Figure 1 – Various risk factors and patient characteristics, availability of resources in the hospital and the surgeons experience determines the outcome of a surgery, including postoperative complications and death.

There are several scoring systems which have been proposed following studies in different sets of patient populations. These systems have been employed for various purposes and each has its advantages and disadvantages. Scoring systems for identifying risks in critically ill patients and in the ICU set up have also been categorized.

Models and Risk Scoring Systems - An overview:

Several scoring systems have been developed, which are applicable to acutely ill patients and patients with comorbidities. In case of patients undergoing surgery, the scoring systems to predict risk can broadly be classified into three groups. These relate to the time of assessment with respect to the procedure. Mortality is generally used as a measure of outcome as it is easy to measure and is a definite endpoint. Some scores predict morbidity as well as mortality, while some scores predict morbidity alone. However, a scoring system to measure return to pre-existing function following surgery and the quality of life is rare.

A brief discussion on the advantages, disadvantages, feasibility and reproducibility of some of these scores which are routinely practiced in the wards and ICU are mentioned.

Pre-operative Risk Assessment Scores

American Society of Anaesthesiologists Score (ASA)

The ASA score was initially devised as a system to collect and tabulate statistical data in anaesthesia, applicable in almost any circumstance. This system, proposed in 1940-41 is attributed to three physicians (Ivan Taylor, Emery Rovenstine and Meyer Saklad).[20]

Thisscore, widely used for risk assessment, was originally aimed at grading the patients "in relation to the physical status only"[21]. This score is based on clinical evaluation alone and is subjective, although the clinician's assessment can be indirectly influenced by the patient's test results which are objective.[18]

ASA Grading:

I Healthy patient
II Mild systemic disease, no functional limitation
III Moderate systemic disease, definite functional limitation
IV Severe systemic disease that is a constant threat to life
V Moribund patient, unlikely to survive 24 hours with/without operation

Figure 2 – ASA Grading

The ASA score was not devisedfor use as a risk scoring system. But, because of its simplicity, universal applicability and consideration of patient parameters, it has been employed for risk prediction. Factors which limit its applicability are subjectivity,wide inter-observer variabilityand lack of specificity in its design. The assumption by this system that the physical fitness of a patient is not related to age is not true. In comparison with young individuals, newborns and the elderly poorly tolerate similar anesthetics in the absence of any systemic illness.[22,23]

The ASA score can be employed to categorize preoperative risk and it is good as an indicator of postoperative morbidity and mortality[17]. This system is comparatively better for stratifying risk than as an indicator of postoperative mortality.

Surgical Risk Scale

The Surgical Risk Scale was devised by Sutton et al[24] as an audit tool for comparing surgical procedures. This has been found to be an effective predictor of mortality. This scoring system is a combination of ASA score, British United Provident Association operative grade and the Confidential Enquiry into Peri-operative Deaths category. The SRS is graded from 3 to 15, each value corresponding to a mortality score. The inclusion of the ASA score makes the SRS a partially subjective score. The POSSUM score and the SRS have been shown to be of comparable accuracy, particularly in patients at higher risk, with SRS being easier to calculate.[25]

Peri-operative Physiological Scores

Acute Physiological and Chronic Health Evaluation (APACHE)

The APACHE scoring system, devised by Knaus et al., 1985, from American ICU patient databases[26], is relatively complex. Though not specifically used to assess patients undergoing surgery, it was found by Goffiet al[27] that this system could be applied "with caution" pre-operatively, in patients undergoing elective as well as emergency procedures. The APACHE II system brought down the variables required to 12 from the earlier 34. APACHE III, which is a further derivation has not been shown to have an improved accuracy in the ICU patients, and has been shown to be poorer when used to assess surgical patients and patients with gastrointestinal disease in some studies.[26]Though well understood and widely used, the calculation of APACHE II is complicated and time consuming. Also, the data needed for calculating this score is not readily obtainable, especially in patients outside the ICU setting.

Simplified Acute Physiology Score

The Simplified Acute Physiology Score (SAPS) is a derivative of the APACHE score. This score is calculated after 24 hours of ICU admission. The SAPS II uses the 13 physiological variables originally included, and also other factors such as type of admission (medical or surgical; elective or emergency) and chronic health problems (Acquired Immuno Deficiency Syndrome, haematological malignancy and metastatic cancer)[28]. Because of the weakness inherent in the SAPS II, APACHE II is favoured for risk assessment in most units.

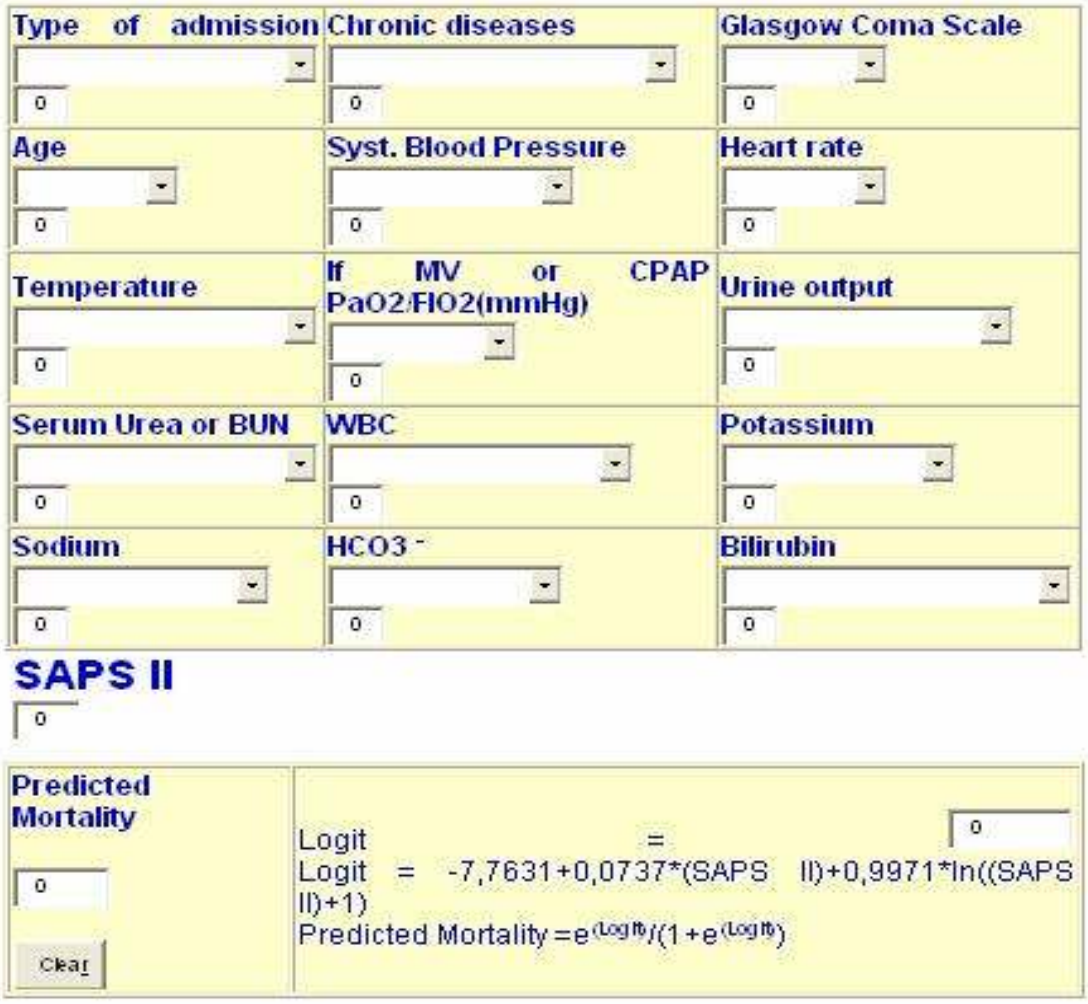


Figure 3 – Simplified Acute Physiology Score

Post-operative Scores

Mortality Prediction Model

The Mortality Prediction Model (MPM) is calculated with data obtained within the first hour of ICU admission (MPM0). The older versions of this system, allowed for calculation after 24 hour (MPM24) or 48 hours (MPM48)[29].The data that is needed for calculating this score is related to the following: admission – elective or emergency, resuscitative measures, comorbidities including chronic renal failure, malignancy, heart rate, systolic blood pressure, and infection, history of previous ICU admission within 6 months, previous history of surgery, age and Glasgow Coma Score. The data allows for a higher degree of consistency and greater completeness.[30]This model provides a better defined way of comparing ICU admissions[31] as this does not rely on the worst criteria during the initial 24 hours of hospitalisation, when compared to the APACHE. The limitations of this model are that it excludes some sub-groups of patients, such as, ICU readmissions, myocardial infarctions and cardiac surgery. SAPS III and APACHE IV, though recently updated, provide better discrimination.

Physiological and Operative Severity Score for EnUmeration of Mortality and Morbidity (POSSUM)

The risk of postoperative morbidity and mortality for a wide range of surgical patients can be predicted with POSSUM. The POSSUM score also allows for comparison.[32] The parameters included in POSSUM are:

Physiological parameters	Operative parameters
Age	Mode of surgery
Cardiac status	Operation type
Respiratory status	Multiple procedures
Glasgow Coma Score	Peritoneal soiling
Pulse rate	Malignancy
Blood pressure	Intraoperative blood loss
Haemoglobin	
White cell count	
Serum sodium	
Serum Potassium	
Urea	
Electrocardiogram	

Table A – Parameters of POSSUM

However, POSSUM has not been validated with respect to the outcome of a procedure or the need for ICU admission electively or peri-operatively. Furthermore, there are speciality specific derivations, such as in colorectal[33] and oesophageal surgery.[34]The advantage of this is that the predictive power has been increased, but the ability to compare between different specialities has been decreased. The lowest predictable expected mortality rate is one per cent in POSSUM. This is applicable for all surgical patients. Thus, there is a possibility of mortality rates being exaggerated in patients undergoing minor procedures.

As POSSUM is based on an exponential equation and the calculated prediction is based on groups, it is not easily applicable to individual surgical patients. These problems have resulted in the derivation of P-POSSUM, widely accepted and used as a risk prediction system

Estimation of Physiologic Ability and Stress

Estimation of Physiologic Ability and Stress (E-PASS) developed by the Japanese as a comparative surgical audit tool[35] uses coefficients and combines pre-operative and operative factors. E-PASS also takes into account the age and the ASA score. This scoring system has been validated in elective gastrointestinal surgery. The post-operative morbidity rate linearly increases as the CRS (Comprehensive Risk Score) increases. A CRS of less than 0.5 corresponds to a postoperative mortality rate of only 0.13%, CRS between 0.5 to less than 1 has a mortality rate of 9.7%, and CRS greater than 1 has a rate of 26.9%. This implies that the E-PASS score is beneficial in predicting postoperative risk, calculating the approximate medical expense, and in comparing the quality of surgical procedure. These results suggest E-PASS may be useful in predicting postsurgical risk, estimating medical expense, and comparing surgical quality. Though partly identical to POSSUM and P-POSSUM, this system is very complex to calculate risk.[36]

Surgical Apgar Score

It was in 1953 that Virginia Apgar formulated a scoring system for evaluating the condition of a newborn. This 10 point score is a simple and effective grading system for predicting the performance of a newborn for the first 28 days.[14] The simplicity of calculating this score led to its universal use in obstetrics as an assessment tool.

Blood loss during a surgical procedure, heart rate and blood pressure has been identified as postoperative risk predictors. The amount of blood lost during a procedure[37] and the hemodynamic stability[38] have been identified as independent risk factors of surgical outcome. The importance of these variables as an easily applicable intraoperative risk assessment tool had however not been recognized.

A surgical model, incorporating these variables was described by Atul Gawande et al. which they published in 2007.[13] Under the NSQIP, 303 patients were randomly selected from those undergoing colectomy at Brigham and Women's Hospital, Boston and were studied. The primary measure of outcome was the incidence of major complication or death within 30 days of surgery. This score was validated in two prospective cohorts: 102 colectomy patients and 767 patients undergoing general or vascular surgical procedures. A 10-point score as shown in table B based

on three parameters was found to be associated with significant 30 day mortality or major complications.

In a cohort study of colectomy cases, Atul Gawande et al found that there was no significant correlation with malignancy, BMI, pulmonary disease, cardiovascular disease, preoperative sepsis, or blood transfusion.

This system, like earlier scoring systems, uses physiological parameters which can be objectively assessed. A particular criticism of this scoring system is that the estimation of blood loss during surgery can be subjective, although according to the authors,the wide categories in the scoring system allow for reasonably accurate estimation. The final score can be used as a predictor to discern patients likely to develop postoperative morbidity or mortality. The study showed that the incidence of major complications was 58.6% and 3.6% with scores of <4 and >8 respectively. In multivariable logistic regression, the lowest mean arterial pressure, log EBL, and the lowest heart rate were found to be independent predictors of outcome.

Table B – Description of the component parameters of the Surgical Apgar Score and its calculation at the end of surgery.

Surgical Apgar Score	**No. of Points**				
Variables	0	1	2	3	4
Estimated blood loss, ml	>1000	600-1000	101-600	<100	-
Lowest mean arterial pressure, mm Hg	<40	40-54	55-69	>70	-
Lowest heart rate/min	>85	76-85	66-75	56-65	<55

1. Occurrence of pathologic bradyarrthymia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escape rhythms, and systole, also receives 0 points for lowest heart rate.
2. Lower the cumulative score, higher the chances of major complication rates and 30 day mortality rates.

The scoring was also further validated by Scott E. Regenbogen, Jesse M. Ehrenfeld et al. who systematically sampled 4119 general and vascular surgery patients at Massachusetts General Hospital.[39]Only 5 per cent of the patients with a score of 9 to 10 developed major complications, including a death rate of 0.1%. In comparison, 56.3% of the patients with a score less than or equal to 4 developed major complications, with death rate being 19.5%. The patients with no complications had a lower value of lowest heart rate and higher value of lowest mean arterial pressure. Also, lower blood loss during a procedure was associated with a lower incidence of major complications. This study by Scott et al also showed no significant difference in the occurrence of complications or 30 day mortality with cancer, steroid therapy, CVA and obesity.

This study showed that these 3 variables had significant statistical relation with postoperative complications and death. This indicates that they are independently capable of predicting both morbidity and mortality and the overall accuracy increases when they are included in a score.

The subjective component in assessing the ASA score also emphasises the role of clinical judgement in risk assessment of patients. To overcome inter-observer bias, the surgical Apgar score provides an objective score which can be easily measured and calculated. Though this

score has been validated, more studies are necessary before it becomes as widely used as the P-POSSUM, APACHE II and NSQIP.

MATERIALS AND METHODS

METHODOLOGY

- **SOURCE OF DATA:**
  - 200 patients admitted in Coimbatore Medical College and Hospital undergoing elective and emergency general surgical procedures
- **STUDY PLACE**:
  - Coimbatore Medical College and Hospital.
- **STUDY DESIGN**:
  - Prospective Observational Study
- **SAMPLE SIZE:**
  - 200 PATIENTS
- **STUDY PERIOD:**
  - SEPTEMBER 2014 – SEPTEMBER 20145
- **INCLUSION CRITERIA**
  - Patients undergoing emergency or elective general surgical procedures under general, epidural, or spinal anaesthesia.
  - Age > 18yrs

- **EXCLUSION CRITERIA**

    - Surgeries under local anaesthesia, not requiring intensive monitoring and regular follow up

200 patients admitted in general surgery department in Coimbatore Medical College taken up for emergency or elective general surgical procedures were studied prospectively during the study period.

- A detailed clinical history was taken from all the patients consented for study. Thorough physical examination was done for all the patients
- Patients were evaluated preoperatively with routine haematological and radiological investigations needed for the surgery
- Intra operative details like amount of blood loss, blood pressure and heart rate were recorded and the surgical Apgar score calculated
- The patients were followed up post operatively and observed for any complications till 30 days and the 30 day mortality and morbidity were tabulated and analysed.

Both elective and emergency surgical procedures were categorized for simplicity as follows (Arvidsson et al)[40]:

Minor and Intermediate

1. Simple alimentary – a) Diagnostic laparoscopy, b) Lap cholecystectomy, c) Lap appendectomy, d) Resection and anastomosis of small bowel, e) Closure of perforation and f) Perianal procedures like repair of rectal prolapse, etc.
2. Breast surgeries – a) Simple mastectomy and b) Modified radical mastectomy with axillary dissection with or without reconstruction.
3. Total thyroidectomy with or without central/lateral neck dissection, parathyroidectomy and simple or total parotidectomy with or without neck dissection.
4. Groin or umbilical hernia repair – a) Anatomical repair like i)Bassini's repair, ii) Shouldice's repair, b) Mesh hernioplasty like Lichtenstein's hernioplasty and c) Laparoscopic hernia repair like i) Total extraperitoneal repair (TEP), ii)Trans abdominal preperitoneal repair (TAPP) and iii) Lap umbilical hernia repair.

5. Skin or soft tissue surgeries – extensive skin grafts for severe and large area burns, flaps like Pectoralis Major Myocutaneous flap, Deltopectoral flap and Sural artery flap.

Major and Extensive

1. Complex alimentary and retroperitoneal surgeries like a) Hemicolectomy and Total colectomy, b) Partial and Total Gastrectomy, c) Superior mesenteric artery thrombosis with extensive small bowel resection, d) Abdominoperineal resection (APR), e) Anterior resection of rectum, f) Esophagectomy and g) Excision of retroperitoneal tumours
2. Hepatobiliary and Pancreas surgery like a) lobectomy and segmentectomy, b) Repair of liver lacerations, c) Open cholecystectomy, d) Open CBD exploration, e) Whipple's procedure, f) pancreatic necrosectomy and g) Open or lap splenectomy.
3. Large Ventral or Incision hernia repair like a) Open technique with intra-abdominal biograft mesh, b) Underlay or overlay mesh hernioplasty with or without abdominoplasty.

Using parameters like **i) ESTIMATED BLOOD LOSS, ii) LOWEST MEAN ARTERIAL PRESSURE AND iii) LOWEST HEART RATE**during the surgical procedure, the Surgical Apgar Score is calculated as shown in the table 2. The cumulative scores are separated into 5 categories as follows – 0-2, 3-4, 5-6, 7-8 and 9-10.

Table B – Surgical Apgar Score

Surgical Apgar Score	**No. of Points**				
Variables	0	1	2	3	4
Estimated blood loss, ml	>1000	600-1000	101-600	<100	-
Lowest mean arterial pressure, mm Hg	<40	40-54	55-69	>70	-
Lowest heart rate/min	>85	76-85	66-75	56-65	<55
1. Occurrence of pathologic bradyarrthymia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escape rhythms, and systole, also receives 0 points for lowest heart rate. 2. Lower the cumulative score, higher the chances of major complication rates and 30 day mortality rates.					

With an estimate of the probability of the morbidity and mortality status derived from the Apgar score, patients are followed up for occurrence of any major complications or death till 30 days postoperatively. Regular follow up of all patients in the study are performed in the OPD and especially of the group with low Apgar scores.

Relevant clinical investigations, either invasive or non-invasive are performed where physiological parameters indicate development of any organ complications. The following events are considered major complications:

1. Acute renal failure,
2. Bleeding that requires transfusion of red blood cells within 72 hours after surgery,
3. Cardiac arrest requiring cardiopulmonary resuscitation,
4. Coma of 24 hours or longer,
5. Deep vein thrombosis,
6. Myocardial infarction,
7. Unplanned intubation,
8. Ventilator use for 48 hours or more,
9. Pneumonia,
10. Pulmonary embolism,
11. Stroke,
12. Wound disruption,
13. Deep or organ space surgical site infections,
14. Sepsis,
15. Septic shock and
16. Systemic inflammatory response syndrome
17. Post op complications of Clavien class III and greater

Table C – Clavien classification of grading the postoperative events based on the severity of complications

Grade	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions. Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside.
Grade II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included.
Grade III	Requiring surgical, endoscopic or radiological intervention.
Grade IIIa	Intervention not under general anesthesia.
Grade IIIb	Intervention under general anesthesia.
Grade IV	Life-threatening complication (Including CNS complications)* requiring IC/ICU management.
Grade IVa	Single organ dysfunction (Including dialysis).
Grade IVb	Multiorgan dysfunction.
Grade V	Death of a patient.
Suffix "d"	If the patient suffers from a complication at the time of discharge (see examples in Table-2), the suffix "d" (for "disability") is added to the respective grade of complication. This label indicates the need for a follow-up to fully evaluate the complication.

**Brain hemorrhage, ischemic stroke, subarrachnoidal bleeding, but excluding transient ischemic attacks. CNS = central nervous system; IC = intermediate care; ICU = intensive care unit. Source = Dindo D, Demartines N, Clavien PA = Classification of surgical complications = a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004; 240: 205-13.*

Urinary tract infections and superficial surgical site infections are not considered major complications.

The tabulated data were analysed.

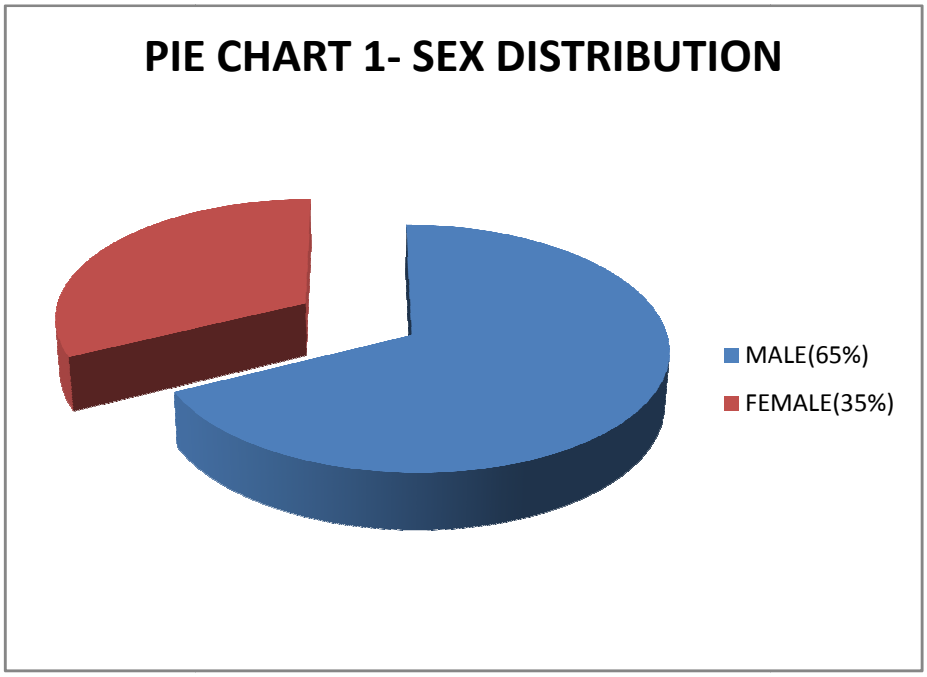
OBSERVATION AND RESULTS

1. **SEX WISE DISTRIBUTION OF CASES:-**

Table 1 - Sex wise distribution of patients

Sex	Number of patients	Percentage
Male	130	65
Female	70	35
Total	**174**	

Chart 1 - Sex wise distribution of patients



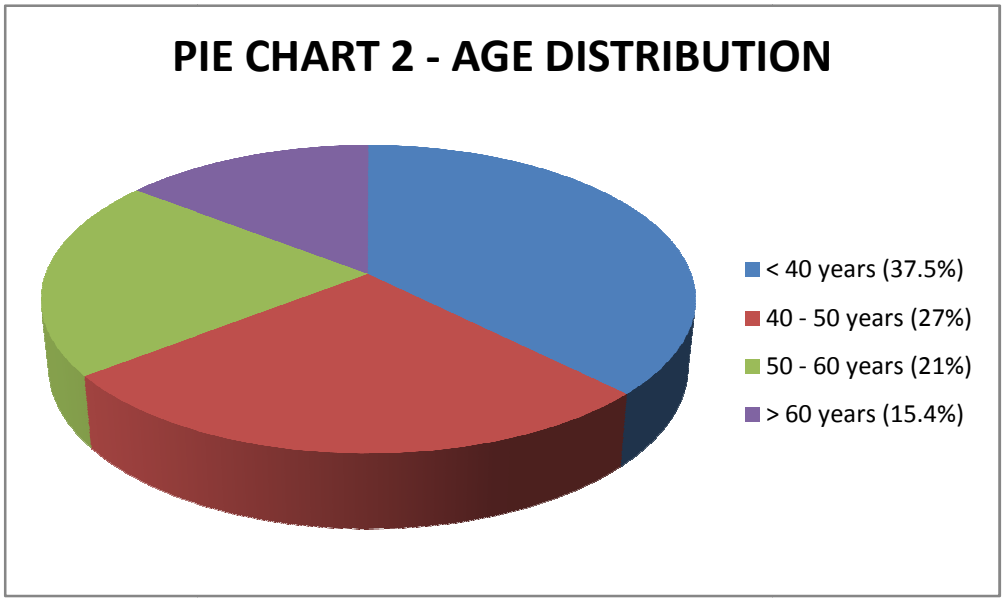
Males accounted for 65 % of the patients in the present study

2. AGE GROUP WISE DISTRIBUTION OF PATIENTS:-

Table 2 -Age group wise distribution of patients

Age group	Number of patients	Percentage
< 40 years	75	37.5%
40 – 50 years	54	27.0%
50 – 60 years	42	21.0%
>60 years	29	14.5%
Total	**200**	

Chart 2 -Age group wise distribution of patients



More than 63.5% of the patients accounting to 125 cases were in the age group of >40 years.

3. TOTAL NUMBER OF ELECTIVE AND EMERGENCY SURGERIES:-

6

Table 3 - Distribution of surgeries into elective and emergency surgeries

7

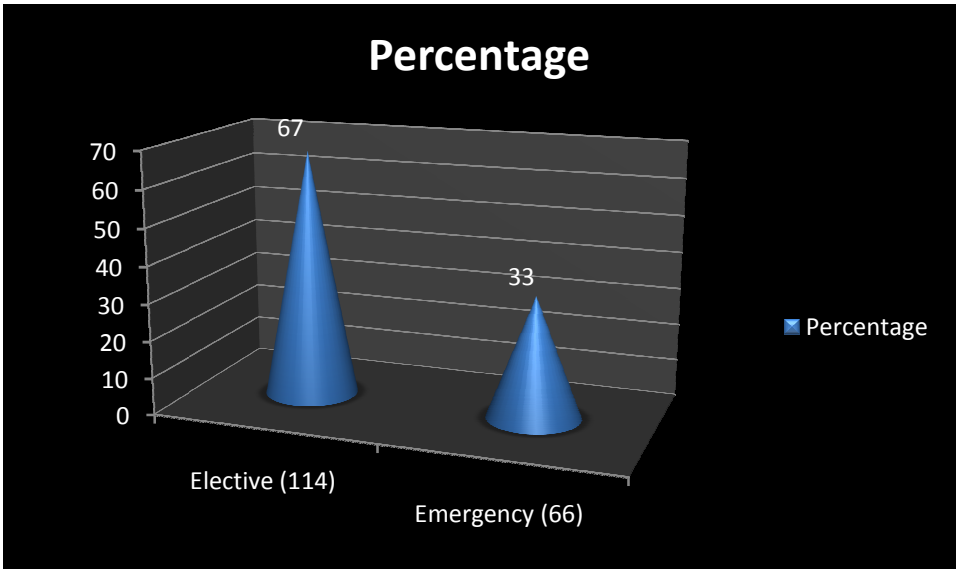
Type of surgery	Number of patients	Percentage
Elective	134	67
Emergency	66	33
Total	200	

%

o

f

Chart 3 - Distribution of surgeries into elective and emergency surgeries



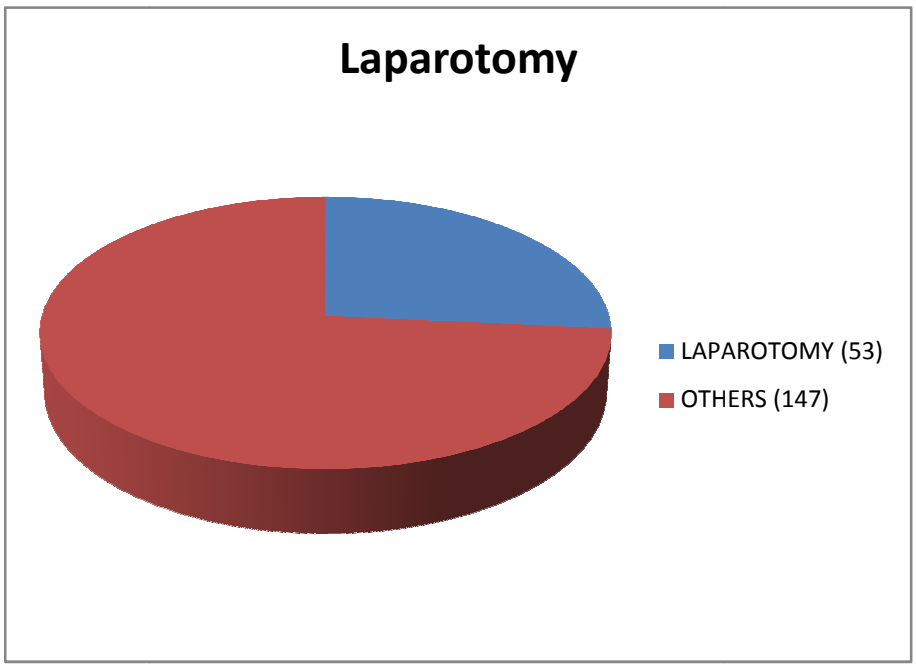
67 % of surgeries were elective in nature. 33 % of the surgeries were emergencies amounting to 1/3rd of the total cases.

4. NUMBER OF LAPAROTOMY

Table 4 - Distribution of surgeries into laparotomy and others

Type of surgery	Number of patients	Percentage
Laparotomy	53	26.5
Others	147	73.5
Total	200	

Chart 4 - Distribution of surgeries into laparotomy and others



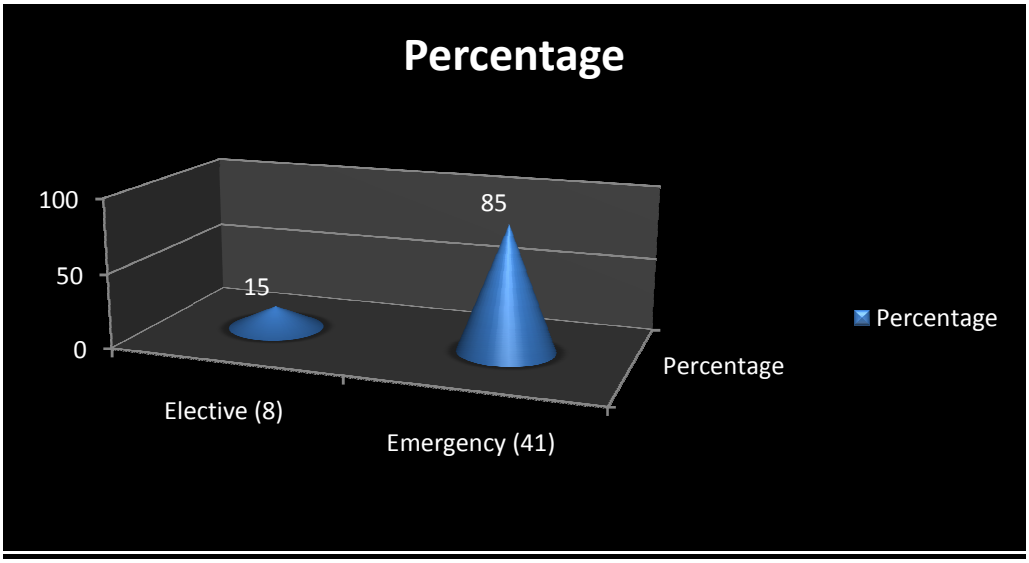
Laparotomy cases constituted 53 which amount to 26.5 % of the cases

5. LAPAROTOMY: ELECTIVE AND EMERGENCY:-

Table 5 - Distribution of laparotomy into elective and emergency surgeries

Type of surgery	Number of patients	Percentage
Elective	8	15
Emergency	45	85
Total	**53**	

Chart 5 - Distribution of laparotomy into elective and emergency surgeries



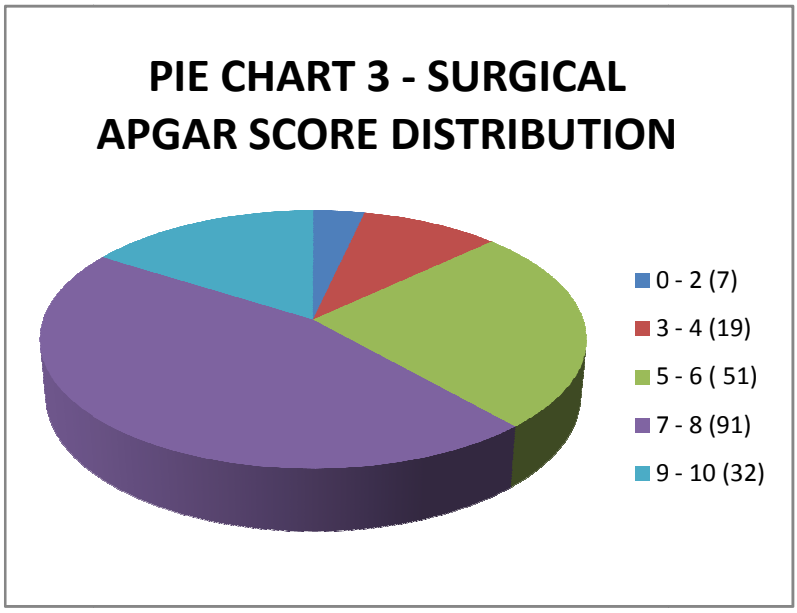
15 % of the laparotomy were elective in nature and 85 % were emergency procedures.

6. APGAR SCORE AND NUMBER OF PATIENTS:-

Table 6 - APGAR score and number of patients

Score	Number of patients	Percentage
0 - 2	7	3.5%
3 - 4	19	9.5%
5 - 6	51	25.5%
7 - 8	91	45.5%
9 - 10	32	16.0%
Total	200	

Chart 6 - APGAR score and number of patients



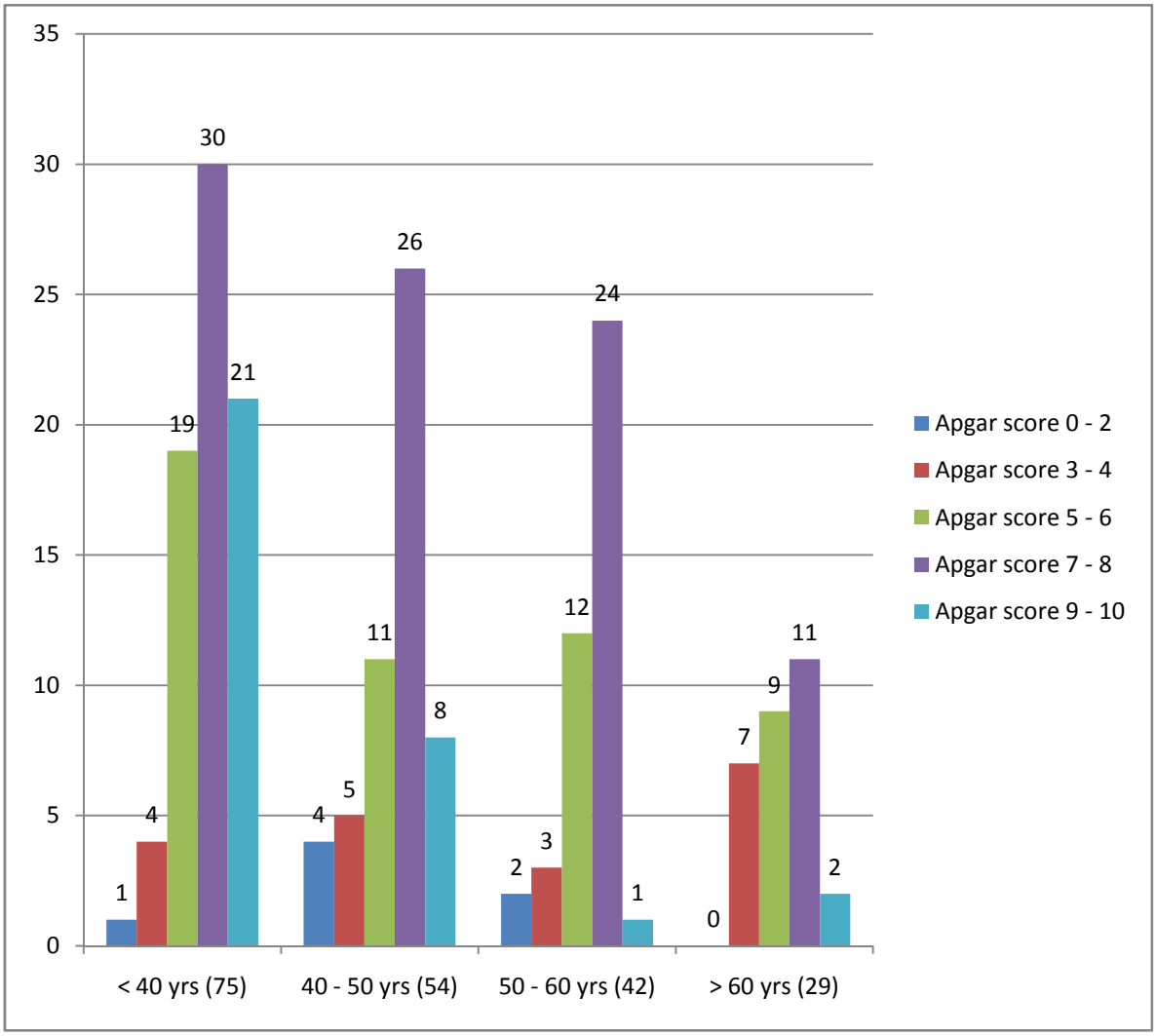
26 patients had an Apgar score of 4 and less than 4, constituting 13 %. The score of 7 to 8 was noted among the maximum number of patients constituting 45.5 %.

7. PERCENTAGE DISTRIBUTION OF SURGICAL APGAR SCORE VS AGE YEAR GROUP

Table 7 – Surgical Apgar Score vs Age Year Group

Score	Age group			
	<40	40 - 50	50 - 60	>60
0 - 2	1	4	2	0
3 - 4	4	5	3	7
5 - 6	19	11	12	9
7 - 8	30	26	24	11
9 - 10	21	8	1	2
Total	75	54	42	29

Chart 7 – Surgical Apgar Score vs Age Year Group



24.1 % of patients (7 patients of 29) in the age group of > 60 years had low Apgar score of < 4.

Only 6.6 % (5 patients of 75) in the younger age group of < 40 years had low Apgar score of < 4.

61.5 % (123 patients of 200) had a high Apgar score of > 7.

8. CLASSIFICATION OF SURGERIES WITH COMPLICATION RATES AND MORTALITY

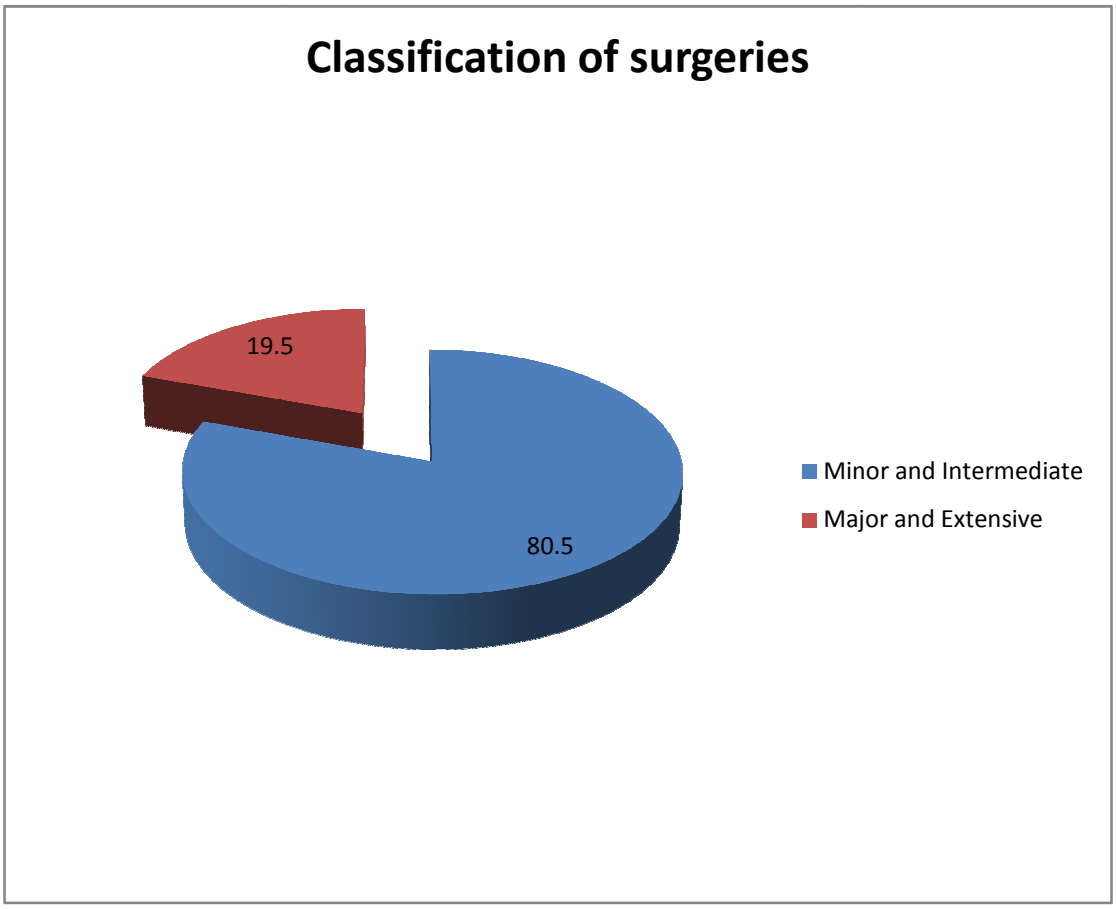
Table 8 - Types of surgery and the complications and mortality

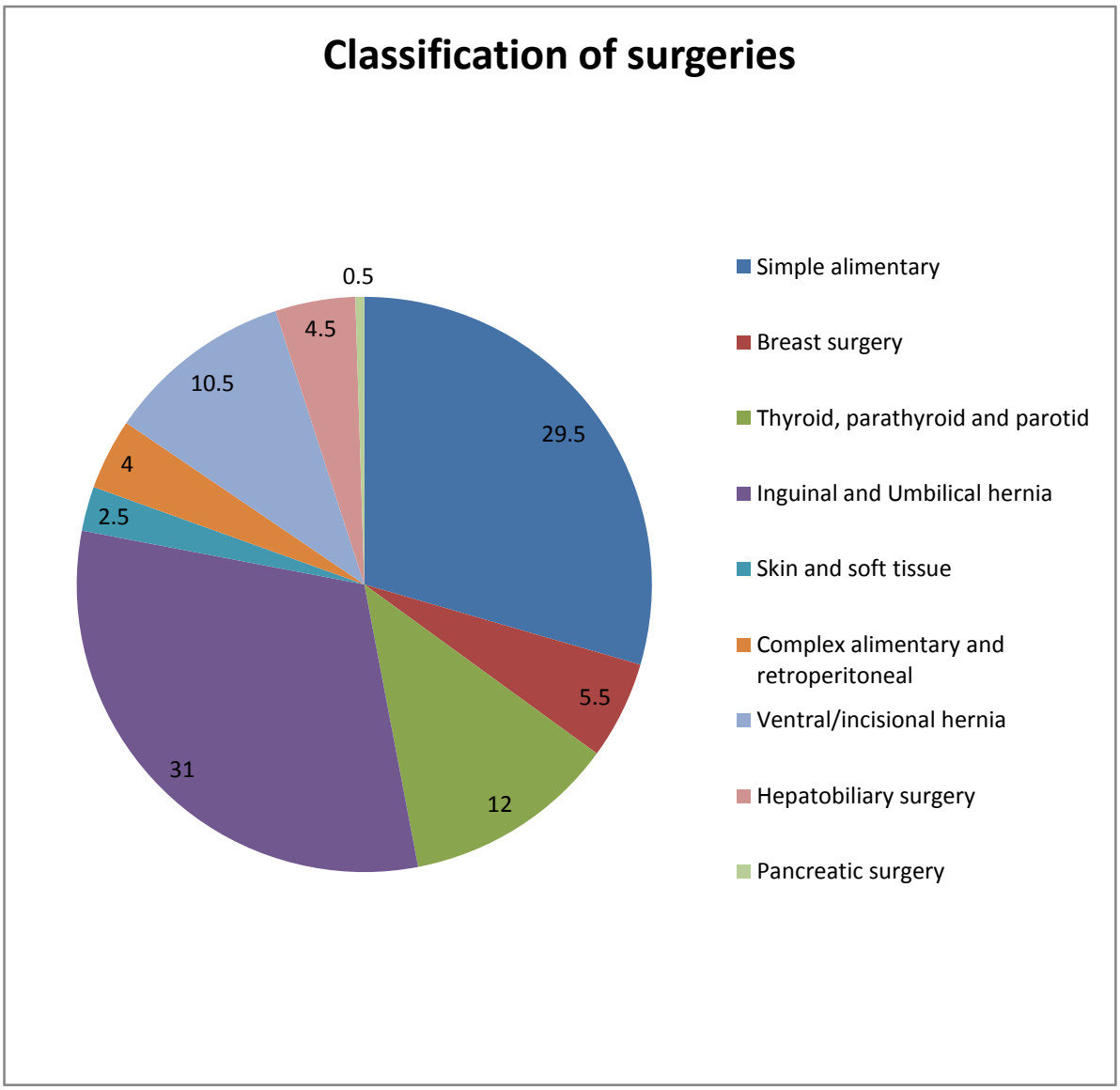
Type of surgery	Number of cases	Major complications	Mortality
Minor and intermediate	**161 (80.5%)**	**9 (5.6%)**	**8 (5%)**
Simple alimentary	59	3 (5.0 %)	7 (11.8%)
Breast surgery	11	1 (9.0%)	0
Thyroid, parathyroid and parotid	24	2 (8.3%)	0
Inguinal and Umbilical Hernia	62	1 (1.6%)	0
Skin and soft tissue	5	2 (40%)	1 (20%)

Major and extensive	**39 (19.5%)**	**7 (17.9%)**	**6 (15.3%)**
Complex alimentary and retroperitoneal	8	2 (25%)	4 (50%)
Ventral/Incisional hernia	21	3 (14.2%)	0
Hepatobiliary surgery	9	2 (22.2%)	1 (11.1%)
Pancreatic surgery	1	0	0
TOTAL	**200**	**16 (8%)**	**14 (7.0%)**

80.5 % cases were minor and intermediate and 19.5 % cases were major and extensive surgeries. Major complications noted at 30 days of postoperative period constituted16 cases i.e., 8 % and 30 day mortality was 7 %.

Major and extensive surgeries had a complication rate of17.9 % and 30 day mortality of 15.3 %. Minor procedures had a complication rate of 5.6 % and mortality rate of 5 %.




Classification of surgeries
0.5
4.5
10.5
29.5
4
2.5
31
5.5
12
Simple alimentary
Breast surgery
Thyroid, parathyroid and parotid
Inguinal and Umbilical hernia
Skin and soft tissue
Complex alimentary and retroperitoneal
Ventral/incisional hernia
Hepatobiliary surgery
Pancreatic surgery

9. SURGICAL APGAR SCORE WITH MAJOR COMPLICATIONS AND MORTALITY

61.5 % of cases belonged to high Apgar score of 7 – 10 (i.e., less complication rates) and 13 % of cases had a low Apgar score of < 4. There was a progressive increase in the number of complications from 3.1 % in score category 9 – 10 to 42.8 % in category 0 – 2. With the 9 – 10 category taken as a reference for assessing the relative risk, there was a 13.71 (0 -2), 3.36 (3 – 4), 4.39 (5 – 6) and 1.05 (7 – 8) times the risk of developing complications when compared to the reference category. In this study, there was no 30 day mortality for patients with an Apgar score >7.

But, the mortality rate was found to be 42.8 % with score of 0 – 2, 42.1 % with score between 3 and 4, and 5.8 % with a score of 5 – 6.

This indicates that patients with a low Apgar score of 4 or less had a very high mortality rate.

Table 9 - SURGICAL APGAR SCORE WITH MAJOR COMPLICATIONS AND MORTALITY

	Surgical Apgar score category				
	0 - 2	3 - 4	5 - 6	7 - 8	9 - 10
No. of patients	7	19	51	91	32
Major complications	3(42.8%)	2(10.5%)	7(13.7%)	3(3.29%)	1(3.1%)
Relative risk for major complications	**13.71**	**3.36**	**4.39**	**1.05**	**1 (reference category)**
Mortality	3(42.8%)	8(42.1%)	3(5.8%)	0	0

10. MAJOR COMPLICATIONS AND MORTALITY IN ELECTIVE AND EMERGENCY SURGERIES VS SURGICAL APGAR SCORE

Major complications were noted in both the patients in the 0 – 2 group, 16.6 % each in the 3 -4 and 5 - 6 score groups.

30 day mortality of 33.3 % was noted in the 3 – 4 group.

Table 10 - Outcomes for elective surgery, in relation to the surgical Apgar score

	ELECTIVE SURGERY – NO. OF CASES 134				
Surgical Apgar score	**No. of cases**	**No. of major complications**	**Percentage**	**Mortality**	**Percentage**
0 - 2	2	2	100	0	0
3 - 4	6	1	16.6	2	33.3
5 - 6	30	5	16.6	0	0
7 - 8	69	3	4.3	0	0
9 - 10	27	1	3.7	0	0
TOTAL	**134**	**12**	**8.9**	**2**	**1.4**

Major complications were noted in 20 % of 0 – 2 group with 60% 30 day mortality, 7.6 % of 3 – 4 group with 46.1 % mortality, 9.5 % of 5 – 6 group with 14.2 % mortality.

No significant mortality and morbidity were noted in patients with Apgar score > 7.

Table 11 - Outcomes for emergency surgery, in relation to the surgical Apgar score

EMERGENCY SURGERY – NO. OF CASES 66

Surgical Apgar score	**No. of cases**	**No. of major complications**	**Percentage**	**Mortality**	**Percentage**
0 – 2	5	1	20	3	60
3 – 4	13	1	7.6	6	46.1
5 – 6	21	2	9.5	3	14.2
7 – 8	23	0	0	0	0
9 - 10	4	0	0	0	0
TOTAL	**66**	**4**	**6**	**12**	**18.1**

11.MAJOR COMPLICATIONS AND MORTALITY IN ELECTIVE AND EMERGENCY LAPAROTOMY VS SURGICAL APGAR SCORE

Major complications were noted in both the patients in the 0 – 2 group. 50 % 30 day mortality was noted in the 3 – 4 group.

Table 12 - Outcomes for elective laparotomy, in relation to the surgical Apgar score

ELECTIVE SURGERY – NO. OF CASES 6

Surgical Apgar score	No. of cases	No. of major complications	Percentage	Mortality	Percentage
0 - 2	2	2	100	0	0
3 - 4	2	0	0	1	50
5 - 6	3	0	0	0	0
7 - 8	1	0	0	0	0
9 - 10	0	0	0	0	0
TOTAL	**8**	**2**	**25**	**1**	**12.5**

20 % of the patients in the 0 – 2 group were noted to have major complications with a mortality rate of 60 %.

7.6 % in the 3 – 4 group developed major complications with a mortality rate of 46.1 %, whereas the morbidity and mortality rates were 10.5 % and 15.7 % respectively in the 5 – 6 group.

No significant morbidity and morbidity were noted with a score above 7.

Table 13 - Outcomes for emergency laparotomy, in relation to the surgical Apgar score

	EMERGENCY LAPAROTOMY – NO. OF CASES 41				
Surgical Apgar score	**No. of Cases**	**No. of major complications**	**Percentage**	**Mortality**	**Percentage**
0 - 2	5	1	20	3	60
3 - 4	13	1	7.6	6	46.1
5 - 6	19	2	10.5	3	15.7
7 - 8	8	0	0	0	0
9 - 10	0	0	0	0	0
TOTAL	**41**	**4**	**9.7**	**12**	**29.2**

12. TEST OF SIGNIFICANCE : COMPLICATIONS

A score of less than 4 shows statistically significant association with the incidence of postoperative complications, when compared to the score of 9 – 10.

Table 14 – Chi Square test for complications

Score category	No. of cases	Major complications	Chi square value	p value	Significant if p < 0.05
Less than 4	26	5	4.011	0.04	Yes
9 - 10	32	1	Reference value		

13.TEST OF SIGNIFICANCE: 30 DAY MORTALITY

There were no deaths noted among patients with a score of 9– 10. The mortality rate was 42.3 % among those with a score of less than 4, which is statistically significant.

Table 15 – Chi Square test for 30 day mortality

Score category	No. of cases	Mortality	Chi square value	p value	Significant if p < 0.05
Less than 4	26	11	16.7	4.4E-05	Yes
9 - 10	32	0	Reference value		

DISCUSSION

DISCUSSION

A simple surgical score, based on blood loss during a surgery, lowest heart rate and lowest mean arterial pressure, provides a meaningful and useful estimate of a patient's condition and the risk of major complications or death after surgery.

All 200 cases admitted in the department of general surgery were evaluated as described earlier in the methods and methodology. All the patients were appropriately assessed and managed according to standard guidelines for the respective disease.

65 % of the patients in our study were male patients. Most of the studies on this scoring system by Gawande et al and Scott et al show a female preponderance of 56 % to 65 % in various study cohorts.[39] However, no association has been noted between gender, the Apgar score and the postoperative prognosis in these studies.

More than 60 % of the patients were in the age group of over 40 years. About 37.5 % patients belonged to the below 40 years age group. Earlier studies have shown an average age distribution of 55.3 years to 63.6 years.[39]

About 24.1 % of patients (7 patients of 29) in the age group > 60 years had a low Apgar score of < 4. Whereas, in the younger age group of

< 40 years, only 6.6 % (5 patients of 75) had a low score of < 4. 61. 5 % of the patients had a high Apgar score of > 7.

67 % of the surgeries in this study were elective in nature and 33 % were emergency procedures amounting to 1/3rd of the total cases. A study by Capewell et al on emergency admissions in surgery showed that between 46 % to 57 % of all surgical admissions are emergency in nature.[40]

Of the 200 cases, 53 cases were laparotomies, with elective laparotomy constituting 15 % (8 cases of 53) and emergency being 85 %.

Majority of the surgeries were minor or intermediate (80.5 %), with major and extensive surgeries amounting to 19.5 %. Even after stratifying the patients by the magnitude of the operation, the score remained a highly significant predictor of outcome.

The incidence of complications in elective surgeries was 8.95 % and the mortality was noted to be 1.49 %, while in emergency surgeries, the complication rate was 6.06 % with the mortality being 18.18 %.

In the case of laparotomy, elective surgery had a complication and mortality rate of 25 % and 12.5 % respectively, while the emergency surgery showed a complication rate of 8.8 % and mortality of 26.6 %.

About 5.6 % of minor surgeries had major complications with a 30 day mortality rate of 5 %. Among major and extensive surgeries, the major complication rate was noted to be 17.9 % and the 30 day mortality rate was 15.3%.

A study by Scott et al showed an incidence of major complications in minor and major surgeries to be 4.8 % and 21.3 % respectively.[41] A mortality rate of 0.4 % vs 3.7 % between minor and major surgeries was seen in a cohort of general surgery.

Of the 200 patients, there was a 7 % 30 day mortality rate, with the rate of complications being 8 %. No complication was noted in 85 % of the patients studied. Mean surgical Apgar score was 6.75. The difference in surgical outcome between patients in different score groups was also statistically significant. Among the 26 (13%) patients with an Apgar score of <4, major complications occurred in19.2 % and a 30 day mortality of 42.3 % was seen. In contrast, among 32 patients with a score of 9 – 10, only 3.1 % suffered a major complication, while no deaths were noted in this group.

With the 9 – 10 category taken as a reference for assessing the relative risk, there was a 13.71 (0 – 2), 3.36 (3 – 4), 4.39 (5 – 6) and 1.05 (7 – 8) times the risk of developing complications. Though no deaths

were noted in the patients with a score over 7, 42.8 % death rate was noted in the score group of 0 – 2 and 42.1 % in the group 3 – 4.

It was also noted that in every 2 point score category, the incidence of both major complications and death was significantly greater than that of patients in the next higher category. A similar result with a relative risk of major complications amongst low scored operations of 16.1 % was noted in a study by Gawande et al when compared with those in the higher scored operation.

The relative risk of predicting a major complication was significantly higher in all the subgroups of the Apgar score for emergency surgeries as compared to elective surgeries. A statistically significant result with an odds ratio of 4.8 % was obtained in a study by Gawande et al for emergency procedures.[13] Other studies have shown complication rates of 43 % and a mortality rate of 4 % in emergency GI procedures.[42]

When compared with other scoring systems, even the P-POSSUM score has no morbidity prediction equation, as a result of the original authors' lack of confidence in the reporting of perioperative complications.[43] Subsequent studies have shown P-POSSUM to both over-predict and under-predict mortality[44] in different settings.

A study on APACHE III risk prediction model by Knaus WA et al, have shown that the overall predictive accuracy of the APACHE III equation within 24 hours of ICU admission following a major surgery was within 3 %.[45]

INFERENCE

This study included patients over 18 years of age. Patients with age group of more than 40 years constituted the majority of the surgical population, being about 63.5 %.

Gender wise, male patients constituted 65 % of the surgical population.

Almost one fourth of the operated patients in the age group of more than 60 years had a low surgical Apgar score of less than 4, whereas only 6.6 % of the patients less than 40 years had a low score.

This study witnessed that surgical Apgar score of less than 2 had a relative risk of 13.71 for the occurrence of major complications, while the 30 day mortality rate was 42.8%.

$2/3^{rd}$ of the cases in this study were operated on an elective basis, with emergency procedures constituting the remaining $1/3^{rd}$.

Though the incidence of major complications in the surgical procedures done on an elective basis is slightly higher than on emergency basis (8.95 % vs 6.06 %), the mortality rate is significantly higher in the emergency surgeries (18.18 % vs 1.49%). The findings were similar in the case of laparotomy with the mortality rate being higher in emergency procedures than in elective procedures.

It is evident from this study that the 30 day mortality is seen to be higher in emergency surgical groups when compared with the elective surgical groups with respect to all the 5 subcategories of Apgar score. Further study needs to be conducted on the emergency subgroups in particular for it to be validated.

CONCLUSION

CONCLUSION

1. The surgical Apgar score has proved to be an important tool in predicting post-operative morbidity and mortality.
2. Higher percentage of patients over 40 years of age have low surgical Apgar scores after general surgical procedures and hence are at risk for major complications, including a high mortality.
3. Patients with low surgical Apgar score would require more intensive monitoring in the postoperative period even if they are undergoing a minor procedure.
4. Mortality rates are twelve times higher in emergency surgeries in comparison to elective cases. In case of laparotomy, the rate is two times higher for emergency laparotomy.
5. The 10 point Apgar scoring system is an easy and fairly accurate method of identifying the patients at risk of complications and mortality in the postoperative period.

SUMMARY

SUMMARY

The aim of this study was to evaluate the efficacy of surgical Apgar score in predicting the morbidity and 30 day mortality in patients undergoing various general surgical procedures. The effectiveness of this score in predicting the postoperative risk in elective and emergency surgeries, including elective and emergency laparotomy, was also studied.

200 patients admitted in the department of general surgery in Coimbatore Medical College Hospital, underwent surgical procedures which were categorized into minor and major surgeries based on the classification by Arvidsson et al. At the end of each procedure, surgical Apgar score was calculated using the three parameters recorded intraoperatively, lowest mean arterial pressure, lowest heart rate and the estimated blood loss.

Higher proportion of patients over 40 years of age had low Apgar score at the end of surgical procedures. This group was at higher risk of having major complications or death during the follow up period. All patients with low Apgar score would require intensive monitoring in the postoperative period even if the patient underwent a minor procedure.

Patients who underwent emergency surgeries irrespective of the Apgar scores had higher 30 day mortality in comparison with the patients who underwent an elective surgery.

In emergency surgeries, patients with all subgroup of scores had higher rates of complications and 30 day mortality. In elective surgeries, lower scores of less than 7 had higher rates of complications and 30 day mortality in comparison to scores of more than 7.

This study thereby concludes that the surgical Apgar score, which is a 10 point outcome score based on the lowest HR, lowest MAP and EBL, discriminated well between groups of patients at high risk and lower than average risk of major complications and death within 30 days of the surgery. This score can also serve as a simple aid in communication among surgeons, post anaesthesia care providers, surgical residents and ICU or surgical ward staff regarding patients' immediate postoperative status. It also helps in conveying the condition of a patient and prognosis after surgery to the attenders.

Thus, the surgical Apgar score is promising as a prognostic measure and a clinical decision making tool.

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PROFORMA

I. Basic Details:

Name of the patient :

Age (in years) :

Sex : M / F

Inpatient Number :

Diagnosis :

Elective / Emergency :

Surgery Done :

II. History:

i. Chief Complaints

ii. Duration

iii. History of present illness

iv. Past History

   a. History of Pulmonary Disease

   b. History of Diabetes

   c. History of Heart Disease

   d. History of previous surgery

v. Personal History

   a. History of smoking / alcoholism

III. General Examination:

Pulse rate :

Blood Pressure :

Respiratory Rate :

Temperature :

IV. Examination of Abdomen:

i. Inspection

ii. Palpation

iii. Percussion

iv. Auscultation

v. Per Rectal Examination

V. Other System Examination:

i. Cardiovascular system

ii. Respiratory system

VI. Clinical Diagnosis:

VII. Intra Operative Details:

- Lowest heart rate
- Lowest mean arterial pressure
- Approximate amount of blood loss

VIII. Post-operative follow up:

No.	Name	Age	Sex	IP number	Diagnosis	Procedure	Score for EBL	Score for lowest MAP	Score for lowest HR	APGAR score	Morbidity	Mortality
1	Shaikh Ali	20	M	41225	Hollow viscus perforation	Emergency laparatomy and perforation closure	3	3	0	6		
2	Bangaj	28	M	40772	Blunt injury abdomen	Emergency laparotomy and splenectomy	0	2	0	2		
3	Guruvayurappan	28	M	42120	Blunt injury abdomen	Emergency laparotomy and splenectomy	0	3	2	5		
4	Muruganantham	36	M	44137	Blunt injury abdomen	Emergency laparotomy and mesenteric tear suturing	0	3	0	3		
5	Jaibunisha	65	F	45556	Strangulated femoral hernia	Resection anastomosis with hernia repair	2	2	0	4		
6	Ashiya Begum	44	F	36783	GIST	Wide excision with splenectomy, distal pancreatectomy	0	1	0	1	Yes	
7	Vadivelu	24	M	48581	Hollow viscus perforation	Emergency laparatomy and perforation closure	3	3	0	6		
8	Haldurai	48	M	50490	Mesenteric ischemia	Emergency laparotomy and resection-anastomosis	2	3	2	7		
9	Sampath Kumar	55	M	50586	Acute intestinal obstruction	Emergency laparotomy and ileal resection-anastomosis	2	2	3	7		
10	Selvaraj	34	M	51568	Acute intestinal obstruction	Emergency laparotomy and band release	2	3	0	5		
11	Kamalam	51	F	48485	Periampullary carcinoma	Whipple's procedure	1	2	3	6		
12	Duraisamy	54	M	54715	Inguinal hernia with undescended testis	Open hernioplasty with orchidectomy	3	3	1	7		
13	Divya	28	F	54740	Solitary nodule thyroid	Left hemithyroidectomy	2	2	1	5		
14	Shanthi	38	F	53170	Distal CBD calculus	CBD exploration	1	2	1	4		
15	Sagunthala	48	F	56475	Obstructed incisional hernia	Anatomical repair	2	3	2	7		
16	Rajan	60	M	56719	Mesenteric ischemia	Emergency laparotomy and resection-anastomosis	2	2	0	4		Yes
17	Muthammal	48	F	53101	Incisional hernia	Open hernioplasty	2	3	3	8		
18	Devi	54	F	54706	Ventral hernia	Open hernioplasty	2	3	2	7		
19	Rajammal	55	F	45572	Carcinoma breast	Right modified radical mastectomy	2	3	0	5	Yes	
20	Moorthy	61	M	56340	Irreducible inguinal hernia	Open hernioplasty	3	3	2	8		
21	Jeyakumar	33	M	56336	Inguinal hernia	Open hernioplasty	3	3	4	10		
22	Mathiyalagan	57	M	56301	Inguinal hernia	Open hernioplasty	3	3	2	8		
23	Govindaraj	67	M	57175	Ventral hernia	Open hernioplasty	3	3	2	8		
24	Maruthachalam	60	M	56320	Inguinal hernia	Open hernioplasty	3	3	2	8		
25	Srinivasa Rao	37	M	58097	Subacute appendicitis	Laparoscopic converted to open appendicectomy	2	2	3	7	Yes	
26	Diwakar	24	M	58203	Hollow viscus perforation	Emergency laparatomy and perforation closure	3	3	0	6		
27	Sundaraperumal	19	M	58302	Hollow viscus perforation	Emergency laparatomy and perforation closure	3	3	1	7		
28	Ravichandran	47	M	58288	Acute intestinal obstruction	Right hemicolectomy	1	1	0	2		Yes
29	Asaraf Ali	42	M	57739	Ileal perforation	Emergency laparotomy and ileal resection-anastomosis	2	2	0	4		Yes
30	Janarthan	26	M	58188	Subacute appendicitis	Laparoscopic appendicectomy	3	2	3	8		
31	Sekar	55	M	58112	Umbilical hernia	Open hernioplasty	3	3	1	7		
32	Balakrishnan	60	M	58753	Inguinal hernia	Open hernioplasty	3	3	1	7		
33	Kannaiyan	55	M	59187	Raw area foot	Skin grafting	3	3	2	8		
34	John	51	M	58078	Incisional hernia	Open hernioplasty	2	3	3	8		
35	Kannidurai	55	M	58066	Inguinal hernia	Open hernioplasty	3	3	2	8		
36	Abitha Beve	60	F	59909	Incisional hernia	Open hernioplasty	2	3	2	7	Yes	
37	Sudhakar	40	M	59898	Blunt injury abdomen - liver laceration	Emergency laparotomy	0	1	2	3		
38	Bijan	20	M	61672	Acute appendicitis	Emergency open appendicectomy	3	3	3	9		
39	Muthulakshmi	45	F	61616	Incisional hernia	Open hernioplasty	3	2	2	7		
40	Poovathal	45	F	57386	Ventral hernia	Open hernioplasty	3	2	3	8		
41	Suresh	35	M	61990	Inguinal hernia	Open hernioplasty	3	3	3	9		
42	Ravindran	60	M	62055	Irreducible inguinal hernia	Open hernioplasty	3	3	1	7		
43	Eswaran	43	M	61582	Blunt injury abdomen	Emergency laparotomy and splenectomy	0	1	0	1	Yes	
44	Balasubramani	30	M	62294	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	2	6		Yes
45	Rathinakumar	27	M	61014	Epididymal cyst	Excision	3	3	3	9		
46	Palaniyammal	65	F	63752	Acute intestinal obstruction	Emergency laparotomy and resection-anastomosis	1	2	1	4		Yes
47	Senniyammal	34	F	64649	Multinodular goitre	Subtotal thyroidectomy	2	2	2	6		
48	Palaniyammal	40	F	64651	Carcinoma breast	Right modified radical mastectomy	2	2	2	6		
49	Bakiyalakshmi	32	F	63058	Multinodular goitre	Subtotal thyroidectomy	2	2	3	7		
50	Andisamy	60	M	63027	Inguinal hernia	Open hernioplasty	3	3	1	7		
51	Srikumar	24	M	63063	Gynaecomastia	Webster's procedure	3	3	2	8		
52	Anburaj	49	M	63017	Incisional hernia	Open hernioplasty	3	2	2	7		

No.	Name	Age	Sex	IP number	Diagnosis	Procedure	Score for EBL	Score for lowest MAP	Score for lowest HR	APGAR score	Morbidity	Mortality
53	Kathirvel	66	M	63280	Epigastric hernia	Open hernioplasty	3	2	1	6		
54	Raj	20	M	69784	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	1	5		
55	Karthikeyan	28	M	64783	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	2	6		
56	Petchiyammal	55	F	64136	Incisional hernia	Open hernioplasty	3	2	2	7		
57	Jasmine	32	F	64680	Cholelithiasis	Laparoscopic cholecystectomy	3	2	3	8		
58	Nagarathinam	50	F	67680	Multinodular goitre	Subtotal thyroidectomy	2	2	1	5	Yes	
59	Natchimuthu	58	M	64655	Incisional hernia	Open hernioplasty	3	3	1	7	Yes	
60	Kaliyappan	61	M	66261	Inguinal hernia	Open hernioplasty	3	3	3	9		
61	Moorthy	36	M	67647	Inguinal hernia	Open hernioplasty	3	3	2	8		
62	Suresh	25	M	67643	Inguinal hernia	Open hernioplasty	3	3	3	9		
63	Meharoon	76	F	61751	Acute intestinal obstruction	Emergency laparotomy and resection-anastomosis	1	2	0	3		Yes
64	Gomathi	90	F	69495	Umbilical hernia	Open hernioplasty	2	3	1	6		
65	Valarmathi	42	F	69446	Carcinoma breast	Right modified radical mastectomy	2	2	2	6		
66	Sasikala	43	F	69550	Multinodular goitre	Subtotal thyroidectomy	2	3	3	8		
67	Yadab Gain	25	M	69651	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	4	4	8		
68	Karuppusamy	75	M	69536	Inguinal hernia	Open hernioplasty	3	3	2	8		
69	Chinnaranjan	65	M	69525	Inguinal hernia	Open hernioplasty	3	3	1	7		
70	Prema	29	F	69928	Mesenteric ischemia	Emergency laparotomy and resection-anastomosis	1	1	1	3		
71	Ponnuthai	76	F	67502	Acute intestinal obstruction	Emergency laparotomy and band release	2	2	2	6		
72	Bathrammal	45	F	77433	Raw area leg	Skin grafting	3	2	1	6	Yes	
73	Parthiban	35	M	64920	Inguinal hernia	Open hernioplasty	3	3	3	9		
74	Ikrambari	63	M	70045	Inguinal hernia	Open hernioplasty	3	3	2	8		
75	Deepan	26	M	71230	Inguinal hernia	Open hernioplasty	3	2	4	9		
76	Karuppusamy	82	M	71113	Acute intestinal obstruction	Emergency laparotomy and colostomy	2	2	1	5		
77	Manikandan	25	M	72984	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	2	6		Yes
78	Kandasamy	55	M	72945	Ventral hernia	Open hernioplasty	2	3	1	6		
79	Naveeth Bevi	55	F	80046	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	1	1	4		
80	Velammal	57	F	72865	Incisional hernia	Open hernioplasty	3	2	1	6	Yes	
81	Mohan	54	M	71227	Blunt injury abdomen	Emergency laparotomy	0	1	2	3		
82	Kalisamy	67	M	71070	Ventral hernia	Open hernioplasty	3	2	1	6		
83	Micheal Patrick	26	M	69505	Medullary carcinoma thyroid	Total thyroidectomy with RND	2	3	2	7		
84	Manikandan	38	M	72969	Acute appendicitis	Emergency open appendicectomy	3	2	3	8		
85	Balan	40	M	72869	Inguinal hernia	Open hernioplasty	3	3	3	9		
86	Siva	43	M	69497	Fistula in ano	Sigmoid loop colostomy	2	2	2	6		
87	Venkatachalamoorthy	45	M	69722	Tongue carcinoma	Left hemiglossectomy with MRND	2	3	2	7		
88	Balakrishnan	39	M	74571	Spermatocoele	Excision	3	3	3	9		
89	Kavitha	34	F	74808	Multinodular goitre	Subtotal thyroidectomy	2	3	4	9		
90	Ponnusamy	48	M	74621	Hydrocoele	Excison and eversion of sac	3	3	2	8		
91	Raj	60	M	76300	Inguinal hernia	Open hernioplasty	3	3	1	7		
92	Surjith	20	M	76277	Inguinal hernia	Open hernioplasty	3	3	3	9		
93	Manjula	40	F	79695	Incisional hernia	Open hernioplasty	2	3	3	8		
94	Sumaiah	43	F	65519	Phaeochromocytoma	Left adrenalectomy	2	0	0	2	Yes	
95	Vadivel	56	M	97208	Cholelithiasis	Laparoscopic cholecystectomy	2	2	1	5		
96	Rabiya	47	F	78002	Acute appendicitis	Emergency open appendicectomy	3	3	3	9		
97	Venkittan	50	M	74652	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	2	6		
98	Veerasamy	45	M	76456	Inguinal hernia	Open hernioplasty	3	3	3	9		
99	Perumal	20	M	79693	Stab injury abdomen	Emergency laparotomy	1	1	1	3		
100	Sathish	22	M	77958	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	3	7		
101	Krishnasamy	54	M	80001	Inguinal hernia	Open hernioplasty	3	3	1	7		
102	Gunasekaran	50	M	80870	Raw area leg	Skin grafting	2	1	0	3		Yes
103	Sathaiya	68	F	80124	Acute intestinal obstruction	Emergency laparotomy and resection-anastomosis	1	1	2	4		Yes
104	Rajee	22	F	81226	Acute appendicitis	Emergency open appendicectomy	3	2	3	8		

No.	Name	Age	Sex	IP number	Diagnosis	Procedure	Score for EBL	Score for lowest MAP	Score for lowest HR	APGAR score	Morbidity	Mortality
105	Govindaraj	54	M	78223	Blunt injury abdomen	Emergency laparotomy	0	1	1	2		Yes
106	Saran Kumar	20	M	396	Torsion testis	Left orchidectomy with right orchidopexy	3	2	3	8		
107	Yohu	85	M	461	Obstructed inguinal hernia	Open hernioplasty	2	2	1	5		
108	Kaliyappan	36	M	300	Gynaecomastia	Webster's procedure	2	3	2	7		
109	Muthu	65	M	415	Inguinal hernia	Open hernioplasty	3	3	2	8		
110	Selvan	52	M	2039	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	2	6		
111	Saraswathy	65	F	81226	Cholelithiasis	Laparoscopic cholecystectomy	3	2	2	7		
112	Thamaraiselvi	56	F	375	Multinodular goitre	Subtotal thyroidectomy	2	3	0	5	Yes	
113	Senthil Kumar	36	M	460	Subacute appendicitis	Laparoscopic appendicectomy	3	3	3	9		
114	Ganesan	22	M	319	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	3	7		
115	Maheshwari	45	F	81225	Carcinoma breast	Left modified radical mastectomy	1	2	1	4		
116	Anandhi	46	F	1256	Solitary nodule thyroid	Left hemithyroidectomy	2	3	2	7		
117	Thirumoorthy	70	M	2127	Inguinal hernia	Open hernioplasty	3	2	1	6		
118	Rangasamy	73	M	355	Inguinal hernia	Open hernioplasty	3	3	1	7		
119	Veerasamy	19	M	3513	Torsion testis	Left orchidectomy with right orchidopexy	3	3	4	10		
120	Mallika	42	F	5125	Cholelithiasis	Laparoscopic cholecystectomy	2	3	2	7		
121	Manjula	30	F	5129	Multinodular goitre	Subtotal thyroidectomy	2	2	2	6		
122	Selvi	30	F	5157	Multinodular goitre	Subtotal thyroidectomy	2	3	3	8		
123	Panjalingam	54	M	1916	Inguinal hernia	Open hernioplasty	3	3	1	7		
124	Suresh Kumar	26	M	5291	Incarcerated hernia	Emergency exploration and hernioplasty	2	2	3	7		
125	Sarath Kumar	19	M	5754	Appendicular perforation	Emergency open appendicectomy	3	2	4	9		
126	Manikandan	44	M	5092	Papillary carcinoma thyroid	Completion thyroidectomy	1	3	2	6		
127	Kumar	33	M	6856	Acute appendicitis	Emergency open appendicectomy	3	2	3	8		
128	Karthik	21	M	6928	Torsion testis	Left orchidectomy with right orchidopexy	3	3	3	9		
129	Malarmannan	30	M	7016	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	3	2	7		
130	Murugesan	38	M	6811	Hydrocoele	Excision and eversion of sac	3	3	2	8		
131	Joh	61	M	6851	Inguinal hernia	Open hernioplasty	3	3	1	7		
132	Murugesan	50	M	6809	Inguinal hernia	Open hernioplasty	3	3	1	7		
133	Parthiban	24	M	8791	Acute intestinal obstruction	Emergency laparotomy and adhesiolysis	2	2	2	6		
134	Pappathy	75	F	6427	Transverse colon carcinoma	Right extended hemicolectomy	1	1	2	4		Yes
135	Bishana	40	F	6570	Subacute appendicitis	Laparoscopic appendicectomy	3	3	3	9		
136	Rajammal	55	F	6806	Epigastric hernia	Open hernioplasty	3	3	2	8		
137	Kamaladevi	31	F	6833	Multinodular goitre	Subtotal thyroidectomy	2	2	1	5	Yes	
138	Saraswathy	57	F	2006	Carcinoma breast	Right modified radical mastectomy	1	3	1	5		
139	Jeya	49	F	8713	Carcinoma breast	Right modified radical mastectomy	1	3	2	6		
140	Chithra	50	F	8735	Multinodular goitre	Subtotal thyroidectomy	2	3	2	7		
141	Pandian	26	M	10727	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	3	7		
142	Lakshmanan	31	M	11627	Pilonidal sinus	Excision	3	3	4	10		
143	Rangasamy	70	M	10529	Inguinal hernia	Open hernioplasty	3	3	3	9		
144	Ganesan	42	M	11540	Hydrocoele	Excision and eversion of sac	3	2	3	8		
145	Sourimuthu	50	M	12353	Inguinal hernia	Open hernioplasty	3	3	2	8		
146	Raja	32	M	14572	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	1	5		
147	Rohitash Kumar	48	M	14173	Inguinal hernia	Open hernioplasty	3	3	3	9		
148	Varathan	60	M	10519	Inguinal hernia	Open hernioplasty	3	3	1	7		
149	Devaraj	60	M	14169	Inguinal hernia	Open hernioplasty	3	3	2	8		
150	Esther	19	F	12334	Acute appendicitis	Emergency open appendicectomy	3	2	3	8		
151	Isakiyammal	37	F	10596	Multinodular goitre	Subtotal thyroidectomy	2	3	2	7		
152	Sumathi	30	F	10636	Solitary nodule thyroid	Left hemithyroidectomy	2	3	1	6		
153	Kannan	27	M	15628	Acute appendicitis	Emergency open appendicectomy	3	2	3	8		
154	Pothuraja	30	M	15858	Hydrocoele	Excison and eversion of sac	3	3	3	9		
155	Rajan	61	M	10570	Malignant melanoma foot	Wide local excison with SSG with ilioinguinal dissection	1	2	1	4	Yes	
156	Babu	45	M	17768	Irreducible inguinal hernia	Open hernioplasty	3	3	2	8		

No.	Name	Age	Sex	IP number	Diagnosis	Procedure	Score for EBL	Score for lowest MAP	Score for lowest HR	APGAR score	Morbidity	Mortality
1	Shaikh Ali	20	M	41225	Hollow viscus perforation	Emergency laparatomy and perforation closure	3	3	0	6		
2	Bangaj	28	M	40772	Blunt injury abdomen	Emergency laparotomy and splenectomy	0	2	0	2		
3	Guruvayurappan	28	M	42120	Blunt injury abdomen	Emergency laparotomy and splenectomy	0	3	2	5		
4	Muruganantham	36	M	44137	Blunt injury abdomen	Emergency laparotomy and mesenteric tear suturing	0	3	0	3		
5	Jaibunisha	65	F	45556	Strangulated femoral hernia	Resection anastomosis with hernia repair	2	2	0	4		
6	Ashiya Begum	44	F	36783	GIST	Wide excision with splenectomy, distal pancreatectomy	0	1	0	1	Yes	
7	Vadivelu	24	M	48581	Hollow viscus perforation	Emergency laparatomy and perforation closure	3	3	0	6		
8	Haldurai	48	M	50490	Mesenteric ischemia	Emergency laparotomy and resection-anastomosis	2	3	2	7		
9	Sampath Kumar	55	M	50586	Acute intestinal obstruction	Emergency laparotomy and ileal resection-anastomosis	2	2	3	7		
10	Selvaraj	34	M	51568	Acute intestinal obstruction	Emergency laparotomy and band release	2	3	0	5		
11	Kamalam	51	F	48485	Periampullary carcinoma	Whipple's procedure	1	2	3	6		
12	Duraisamy	54	M	54715	Inguinal hernia with undescended testis	Open hernioplasty with orchidectomy	3	3	1	7		
13	Divya	28	F	54740	Solitary nodule thyroid	Left hemithyroidectomy	2	2	1	5		
14	Shanthi	38	F	53170	Distal CBD calculus	CBD exploration	1	2	1	4		
15	Sagunthala	48	F	56475	Obstructed incisional hernia	Anatomical repair	2	3	2	7		
16	Rajan	60	M	56719	Mesenteric ischemia	Emergency laparotomy and resection-anastomosis	2	2	0	4		Yes
17	Muthammal	48	F	53101	Incisional hernia	Open hernioplasty	2	3	3	8		
18	Devi	54	F	54706	Ventral hernia	Open hernioplasty	2	3	2	7		
19	Rajammal	55	F	45572	Carcinoma breast	Right modified radical mastectomy	2	3	0	5	Yes	
20	Moorthy	61	M	56340	Irreducible inguinal hernia	Open hernioplasty	3	3	2	8		
21	Jeyakumar	33	M	56336	Inguinal hernia	Open hernioplasty	3	3	4	10		
22	Mathiyalagan	57	M	56301	Inguinal hernia	Open hernioplasty	3	3	2	8		
23	Govindaraj	67	M	57175	Ventral hernia	Open hernioplasty	3	3	2	8		
24	Maruthachalam	60	M	56320	Inguinal hernia	Open hernioplasty	3	3	2	8		
25	Srinivasa Rao	37	M	58097	Subacute appendicitis	Laparoscopic converted to open appendicectomy	2	2	3	7	Yes	
26	Diwakar	24	M	58203	Hollow viscus perforation	Emergency laparatomy and perforation closure	3	3	0	6		
27	Sundaraperumal	19	M	58302	Hollow viscus perforation	Emergency laparatomy and perforation closure	3	3	1	7		
28	Ravichandran	47	M	58288	Acute intestinal obstruction	Right hemicolectomy	1	1	0	2		Yes
29	Asaraf Ali	42	M	57739	Ileal perforation	Emergency laparotomy and ileal resection-anastomosis	2	2	0	4		Yes
30	Janarthan	26	M	58188	Subacute appendicitis	Laparoscopic appendicectomy	3	2	3	8		
31	Sekar	55	M	58112	Umbilical hernia	Open hernioplasty	3	3	1	7		
32	Balakrishnan	60	M	58753	Inguinal hernia	Open hernioplasty	3	3	1	7		
33	Kannaiyan	55	M	59187	Raw area foot	Skin grafting	3	3	2	8		
34	John	51	M	58078	Incisional hernia	Open hernioplasty	2	3	3	8		
35	Kannidurai	55	M	58066	Inguinal hernia	Open hernioplasty	3	3	2	8		
36	Abitha Beve	60	F	59909	Incisional hernia	Open hernioplasty	2	3	2	7	Yes	
37	Sudhakar	40	M	59898	Blunt injury abdomen - liver laceration	Emergency laparotomy	0	1	2	3		
38	Bijan	20	M	61672	Acute appendicitis	Emergency open appendicectomy	3	3	3	9		
39	Muthulakshmi	45	F	61616	Incisional hernia	Open hernioplasty	3	2	2	7		
40	Poovathal	45	F	57386	Ventral hernia	Open hernioplasty	3	2	3	8		
41	Suresh	35	M	61990	Inguinal hernia	Open hernioplasty	3	3	3	9		
42	Ravindran	60	M	62055	Irreducible inguinal hernia	Open hernioplasty	3	3	1	7		
43	Eswaran	43	M	61582	Blunt injury abdomen	Emergency laparotomy and splenectomy	0	1	0	1	Yes	
44	Balasubramani	30	M	62294	Hollow viscus perforation	Emergency laparotomy and perforation closure	2	2	2	6		Yes
45	Rathinakumar	27	M	61014	Epididymal cyst	Excision	3	3	3	9		
46	Palaniyammal	65	F	63752	Acute intestinal obstruction	Emergency laparotomy and resection-anastomosis	1	2	1	4		Yes
47	Senniyammal	34	F	64649	Multinodular goitre	Subtotal thyroidectomy	2	2	2	6		
48	Palaniyammal	40	F	64651	Carcinoma breast	Right modified radical mastectomy	2	2	2	6		
49	Bakiyalakshmi	32	F	63058	Multinodular goitre	Subtotal thyroidectomy	2	2	3	7		
50	Andisamy	60	M	63027	Inguinal hernia	Open hernioplasty	3	3	1	7		
51	Srikumar	24	M	63063	Gynaecomastia	Webster's procedure	3	3	2	8		
52	Anburaj	49	M	63017	Incisional hernia	Open hernioplasty	3	2	2	7		

KEY TO MASTER CHART

EBL - Estimated blood loss

MAP - Mean arterial pressure

HR - Heart rate

INFORMED CONSENT

DEPARTMENT OF GENERAL SURGERY

Coimbatore Medical College, Coimbatore

I have been invited to participate in the researchproject titled "**A 10 point surgical Apgar score to predict post-operative morbidity and mortality in patients undergoing general surgical procedures.**"

I understand, it will be answering a set of questionnaire, undergo physical examination, investigations and appropriate treatment.I also give consent to utilise my personal details for study purpose and can be contacted if necessary.I am aware that I have the right to withdraw at any time which will not affect my medical care.

Name of the participant :

Signature :

Date :